THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Anil V. Nadkarni et al.	)
Serial No.:	08/678,776	) Group Art Unit: 1742
Filed:	July 11, 1996	) Examiner: D. Jenkins
Title:	"Lead Free Frangible Bullets and Process for Making Same"	)

January 25, 1999

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Assistant Commissioner for Patents
Washington, D.C. 20231

DECLARATION OF ANIL V. NADKARNI IN SUPPORT OF THE NOVELTY OF THE CLAIMED INVENTION

Sir:

I, Anil V. Nadkarni, hereby declare as follows:

1. I am currently employed by OMG Americas (formerly SCM Metal Products) as Director of GlidCop ® Technology (dispersion strengthened copper technology) having held that position since January, 1990. Among my other responsibilities as Director of GlidCop® Technology is to plan, oversee and conduct research and development of metal powder products, including bullets manufactured by rigid die powder metallurgy. A brief summary of my work experience is attached as Exhibit A.

2. I am co-inventor of the invention of the above-captioned patent application and am familiar with the contents of this application and portions of its prosecution history. I understand that claims 1-66 are the presently pending claims in the application and that they have been amended by a Reply To The October 27, 1998 Office Action to be filed concurrently with this Declaration. The claims are directed to a frangible bullet comprising at least 60% copper which is manufactured by pressing a copper-containing powder in a die, then sintering the pressed powder compact, with the sintering process being partially impeded either (i) by the addition of a frangibility effecting additive to the powder, (ii) through control of the density of the pressed powder compact, or (iii) through control of sintering temperature or time, or any combination thereof, so as to yield a bullet capable of fragmenting upon impact. Also, there are presented claims directed to a method of making such a frangible bullet, and a powder useful for manufacturing a frangible item. A copy of pending claims 1-66, as now amended, is attached as Exhibit B.

3. I have read the Office Action dated October 27, 1998 issued in connection with this application. I understand that in the October 27, 1998 Office Action, claims 1-3, 9, 10, and 24-26 were rejected as being anticipated by Great Britain Patent No. 531,389 (Woodworth) and that claims 11, 12, 21-23, and 27-34 were rejected as being unpatentably obvious over

Woodworth, either alone, or in view of disclosure in the *Condensed Chemical Dictionary*, 10th Ed. (1981). The Examiner's position on the anticipation rejection as stated in the October 27, 1998 Office Action is as follows:

> "Woodworth discloses a bullet comprising:
>
> 90 percent by weight copper (page 3, line 16);
>
> wherein said bullet is formed by pressing a powder comprising copper in a die (page 2, line 25) and sintering (page 2, col. (sic, line) 35).
>
> Woodworth further discloses wherein said bullet is lead free (page 3, lines 15-21).
>
> Woodworth further discloses wherein a solid lubricant is added to the powder (page 2, last full paragraph) and shows graphite as an additive (page 3, line 21).
>
> Woodworth does not disclose the frangible characteristics of his bullet. However, Woodworth['s] use of the same materials and approximate processing parameters would produce a bullet with similar characteristics to Applicant's."

4. It is my opinion that the pending claims define a materially different invention than the subject matter disclosed by the Woodworth reference cited in the rejections. I am making this Declaration to substantiate the novelty of the invention defined by the pending claims.

5. Regarding the novelty of the invention being claimed in pending claims 1-3, 9-12, and 21-34, each of these pending claims is directed to a frangible bullet manufactured by sintering a copper-containing powder where the sintering process is partially impeded so as to

produce a bullet capable of fragmenting upon impact with a target (claims 1-3, 9-12, and 21-25) or a method of making a frangible bullet by sintering a pressed, copper-containing powder where the sintering process is partially impeded so as to produce a bullet capable of fragmenting upon impact with a target (claims 26-34). It is my opinion and conclusion that Woodworth does not disclose either (i) a frangible bullet, or (ii) partially impeding the sintering process so as to produce a bullet capable of fragmenting upon impact with a target.

6. In further detail, it is my opinion and conclusion that Woodworth does not teach or suggest the present invention at hand because it discloses only non-frangible, ductile bullets and complete sintering so as to produce a bullet that does not fragment upon impact with a target.

The teachings of Woodworth are not directed at producing a frangible bullet. Instead, Woodworth teaches that previously known methods for producing a porous bronze bearing may be utilized to produce a bullet that has great strength and is self-lubricating against the barrel of a weapon during firing. Evidence of this is shown on page 2, lines 24 through 30, where Woodworth discusses the manufacture of a bearing "*which will resist great crushing, pressures and fracturing strains.*" Further evidence is shown on page 2, lines 66 through 74 and lines 98 through 100, where Woodworth discusses how absorbed lubricant reduces barrel wear and that

his bullet "*preferably contains absorbed lubricant.*" Woodworth does not disclose in any portion of his patent that frangibility is a desired or inherent characteristic of his bullet.

On page 3, lines 10 through 38, Woodworth discloses a "*powdered metal composition which is particularly advantageous for the formation of bullets.*" Further disclosed is a method of pressing the composition into a bullet and the conditions of atmosphere and temperature under which the bullet should be sintered. This passage reads as follows:

> "The following formula is an example of the known type of powdered metal composition which is particularly advantageous for the formation of bullets:

		Parts by weight
Powdered copper	-	90
Powdered tin -	-	10
Stearic acid -	-	½
Boric acid -	-	½
Graphite -	-	1 ½

> The bullet, generally designated by the numeral 10 in Figs. 1 and 2 is formed by briquetting a charge 11 of powdered metals in a die, illustrated at 12, under the action of a compression 13 ram. The die 12 is provided with a cavity 14 for receiving the powdered metal charge 11 and it has an axially extending passage 15 leading from the lower end of the cavity 14 for accommodating a plunger 16 by which the briquette resulting from compression of the powdered metal charge may be conveniently removed from the die. The briquette is then sintered in a non-oxidizing or reducing atmosphere at a temperature of from substantially 1500° F. to 1550° F."

Anil V. Nadkarni

Education:

Bachelor of Technology, Metallurgical Engineering, Indian Institute of Technology, Bombay, India, May 1967.

Master of Science, Metallurgical Engineering, University of Wisconsin, Madison, Wisconsin, January 1969, with emphasis on Powder Metallurgy.
Thesis: Effect of Particle Size and Shape on the Shrinkage Behavior of Stainless Steel Powder Compacts during Sintering.

Experience:

February 1969 to Date: SCM Metal Products - OMG Americas
Present Position: Director, GlidCop® Technology

Directed a research project on dimensional control of copper – tin powder compacts during sintering.

Developed a commercial process for making GlidCop® Dispersion Strengthened Copper: Gas atomization to produce copper-aluminum alloy powders
Internal oxidation process for preferential oxidation of aluminum
Consolidation technology to convert powder into wrought forms
Cold forming technology for making resistance welding electrodes
Near net shape processes for making full dense GlidCop® parts
Low oxygen grades for electronic applications
Composite materials for improved strength, controlled thermal expansion, etc.
Dispersion strengthened copper alloys for high strength applications
Materials for valve seat inserts and guides for high performance automobile engines

Developed a commercial process for making lead-free frangible bullets:
Selection of copper, copper alloys, additives, etc.
Near net shape process for making bullets from powder

Overall Direction of Following Programs:
Development of copper alloy brazing pastes for assembling copper radiators
Development of catalysts for manufacture of silanes

To one familiar with the metallurgy of copper and tin, and the manufacture of porous bronze bearings, it would be expected that bullets manufactured according to the teachings of Woodworth would be non-frangible. Since tin melts at only 451° F, a phenomenon known as liquid-phase sintering would occur when a compacted mixture of 90 parts copper and 10 parts tin is heated within the temperature range of 1500° F to 1550° F disclosed by Woodworth. The molten tin would quickly combine with the copper particles to form a ductile alloy of bronze. The compact would be porous, but the newly formed particles of bronze would be very strongly bonded together. For a porous bronze bearing whose purpose is to support a rotating shaft, strongly bonded particles would be desirable. However, this is entirely opposite of the properties desired in frangible bullets that are designed to shatter into small fragments.

Woodworth does not explicitly explain why graphite is a component of the mixture of powdered materials he suggests as "*particularly advantageous for the formation of bullets.*" However, graphite is a known additive for enhancing the lubrication between porous bronze bearings and shafts. Since Woodworth is concerned with bullets that reduce barrel wear, and does not mention frangibility, it follows that the graphite is for improved lubrication. Under certain conditions as proposed by the present application, graphite may be used to enhance frangibility. But, at the sintering temperatures taught by Woodworth, the effect of the graphite is negated by the overwhelming effect of the liquid-phase sintering.

7. To confirm that Woodworth does not teach a frangible bullet, a quantity of bullets was manufactured, with strict adherence to Woodworth's teachings as outlined below, to demonstrate that bullets prepared in accordance with the teachings of Woodworth are not frangible:

Step 1. A powdered metal mixture was made by blending the following components in a V-cone blender for about 20 minutes:

90 parts by weight copper powder	(OMG Americas grade 150 RXM)
10 parts by weight tin powder	(OMG Americas grade M-40)
0.5 parts by weight stearic acid	(Witco Industrene 8718)
0.5 parts by weight boric acid	(U. S. Borax powdered boric acid)
1.5 parts by weight graphite	(Lonza T-44 powdered graphite)

Step 2. A quantity of .40 caliber x 155 grain bullets was pressed from the mixture of Step 1 using a molding pressure of 121,000 psi and tooling very similar to that described and illustrated by Woodworth. OMG Americas regularly uses this molding pressure and tooling to produce frangible bullets for the commercial market.

Step 3. A quantity of .40 caliber x 138 grain bullets was pressed in a similar manner as described in Step 2 with the exception that the molding pressure was reduced to 75,000 psi. Woodworth suggests this molding pressure on page 1, line 74.

Step 4. All molded bullets were sintered under a non-oxidizing, nitrogen atmosphere at 1525° F for 20 minutes.

As a means of quantifying the frangibility of bullets, OMG Americas previously developed a Drop Test as illustrated in Exhibit C. A weight of 14 pounds is dropped from a height of 80

inches and allowed to impact against a bullet. The weight is guided as it falls, squarely striking the bullet with energy of about 90 ft-lbs. A typical frangible bullet will shatter into many fragments that are retained on a plastic sheet at the base of the test fixture. These fragments are collected and passed over a series of screens of decreasing mesh size. Greater quantities of fragments that pass through the smaller mesh sizes indicate greater frangibility. Results of this test correlate well with results obtained through the actual firing of frangible bullets against a target.

The .40 caliber x 155 grain and .40 caliber x 138 grain bullets manufactured according to the teachings of Woodworth were tested using the Drop Test described above. As shown in the photographs of Exhibit D, the bullets did not shatter into fragments when impacted by the dropped weight. Instead, the bullets showed great strength and ductility by simply deforming in shape.

Bullets having the characteristics as described above would be very dangerous to use at a typical modern firing range. The bullets are not frangible and therefore do not expend their energy by shattering into small fragments when striking a target. They would very likely ricochet or bounce back with great energy in the direction of the shooter. Bullets that ricochet or bounce back are known to have inflicted serious injuries and elimination of such bullets is the driving

force behind the development of frangible bullets.

Woodworth teaches liquid-phase sintering as described above. The bullets made by that process contain two or more powders, one of which melts. At the sintering conditions described by Woodworth, complete sintering occurs. In contrast, the present application teaches sintering under conditions that partially impede the sintering process. For example, the instant application discloses a frangible bullet composed entirely of copper powder. (A small amount of Acrawax C, a common molding lubricant, is added to facilitate removal of the compacted powder from the molding die. However, the molding lubricant, by design, vaporizes entirely out of the compacted powder during heating to sintering temperatures.) In this embodiment, sintering is at a temperature between about 1500° F and 1900° F. Since copper melts at 1983° F, no melting or liquid- phase sintering occurs. Rather, the particles of copper are bonded together by a mechanism known as solid-state diffusion. Energy supplied in the form of heat causes diffusion among the copper atoms at the points where the individual copper particles touch. This creates bonds that hold the compacted bullet together. By controlling the temperature and time of sintering in the ranges described in this application, the sintering is partially impeded. When the frangible bullet of the present invention is subjected to the Drop Test described above, the bullet breaks into pieces as shown in the photographs of Exhibit E.

The present application also discloses frangible bullets compacted from brass and bronze powders. In each case a single alloy powder is used. These alloys have higher melting temperatures than tin and therefore higher sintering temperatures may be employed without complete liquid-phase bonding between the metal particles, unlike the sintering taught by Woodworth. In contrast, in the present invention each of these alloys is sintered under conditions such as to partially impede the sintering process. At the lower end of the sintering temperature range, solid-state diffusion is the mechanism creating bonds between the metal particles. At the upper end of the range, small pockets of liquid alloy begin to develop because of changes in the solubility of zinc and tin in copper at the higher temperatures. Liquid-phase sintering, thus, begins creating additional bonds between the metal particles. The frangibility of the bullets can be varied from ones having only generally weak solid-state diffusion bonds, to those also having some liquid-phase bonds. As with the pure copper bullet prepared in accordance with this invention, brass and bronze bullets of the present invention, when subjected to the Drop Test, shatter as shown in the photographs of Exhibits F and G, respectively.

By practice of the invention of the present application, one skilled in the art may manufacture a frangible bullet using a mixture of powdered materials very similar to those disclosed by Woodworth. A bullet molded from a mixture of 90 parts by weight copper powder, 10 parts by weight tin powder and 0.75 parts by weight molding lubricant, when sintered under

conditions that partially impede the sintering process, will be frangible. As an example of this, a quantity of .45 cal x 170 grain bullets was molded from a premixed bronze powder manufactured by OMG Americas and known as Grade PMB-8. This material is a graphite-free mixture of copper, tin and lubricant powders in the proportions stated above and it is intended for use in the manufacture of porous bronze bearings. Quantities of the bullets were sintered at four different temperatures: 500° F, 600° F, 700° F and 1200° F. Afterwards, the bullets were tested for frangibility using the Drop Test. As shown in photographs 1 through 4 of Exhibit H, bullets sintered at 500° F to 700° F were frangible while those sintered at 1200° F were not frangible. This effect can be explained by the fact that, at the lower temperatures of 500° F to 700° F, the sintering is limited in accordance with the present invention. At the higher temperature of 1200 ° F (and the 1500° F to 1550° F described by Woodworth) a much higher degree of sintering occurs and strong ductile bonds are created between the particles.

8. In summary, a number of individual metal and alloy powders, and mixtures thereof may be compacted and sintered into bullets. However, in order to make a frangible bullet, the sintering must be carried out under conditions that partially impede the sintering process as taught by the present application. Woodworth does not disclose a frangible bullet, but merely teaches that a known process for making strong and ductile porous bronze bearings can be used also to make strong and ductile porous bronze bullets. As such Woodworth discloses neither a

frangible bullet nor sintering under conditions that partially impede the sintering process so as to produce a bullet capable of fragmenting upon impact with a target.

9. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that any such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Dated: January 26, 1999

Anil V. Nadkarni

Anil V. Nadkarni

Attachments

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A

Other:

Patents:
18 issued US patents, about half also issued in foreign countries
2 patent applications pending

Technical Articles:
Over 20 published in various trade publications

Contributions:
Dispersion Strengthened Copper - Metals Handbook, Powder Metallurgy, Vol. 7, 1984
Resistance Welding Electrodes - Metals Handbook, Powder Metallurgy, Vol. 7, 1984
Copper Powder Metallurgy Alloys and Composites - Metals Handbook, Powder Metallurgy, Vol. 7, 1998

Awards:
SCM Corporation Outstanding Scientific and Technical Achievement Award - 1973
Chemical Metallurgical Division Scientific and Technical Achievement Award - 1983
SCM Corporation Outstanding Scientific and Technical Achievement Award - 1984

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Applicants:	Anil V. Nadkarni et al.	)
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Serial No.:	08/678,776	)
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Filed:	July 11, 1996	)
		)
Title:	"Lead Free Frangible Bullets and Process for Making Same"	)

PENDING CLAIMS

1. (Thrice Amended) A frangible bullet comprising at least 60 percent by weight copper and manufactured by pressing a copper-containing powder in a die <u>to form a pressed powder compact</u> and subsequently sintering <u>said pressed powder compact,</u> [it under conditions] <u>wherein said sintering is partially impeded either</u>

<u>(i) by the addition of a frangibility effecting additive to said powder, or</u>

<u>(ii) through control of density of said pressed powder compact, or</u>

<u>(iii) through control of sintering temperature, or sintering time, or</u>

<u>any combination of the above;</u> so as to produce a bullet capable of fragmenting upon impact with a target.

2. The bullet of claim 1 wherein the bullet is lead-free.

3. (Twice Amended) The bullet of claim [1] <u>53</u> wherein the [powder further] <u>frangibility effecting additive</u> comprises an oxide additive.

4. The bullet of claim 3 wherein the oxide additive is selected from the group consisting of SiO_2, Al_2O_3, TiO_2,, MgO, MoO_3 and combinations thereof.

5. The bullet of claim 4 wherein the oxide additive is SiO_2, Al_2O_3, TiO_2, MgO or a combination thereof and the amount of oxide additive is from 0.05 to 1.0 percent by weight.

6. The bullet of claim 4 wherein the powder comprises from 0.05 to 0.50 percent by weight of MoO_3.

7. (Amended) The bullet of claim [1] <u>53</u> wherein the powder is a dispersion strengthened copper powder.

8. The bullet of claim 7 wherein the dispersion strengthened copper powder is made by internal oxidation of a dilute solid solution alloy of copper and a reactive element selected from the group consisting of Si, Al, Ti, and Mg.

9. (Twice Amended) The bullet of claim [1] <u>53</u> wherein the [powder further] <u>frangibility effecting</u>

additive comprises a solid lubricant additive.

10. The bullet of claim 9 wherein the solid lubricant additive is selected from the group consisting of graphite, MoS_2, MnS, CaF_2, and combinations thereof.

11. The bullet of claim 10 wherein the solid lubricant additive is graphite, MnS, CaF_2, or a combination thereof and the amount of solid lubricant additive is from 0.05 to 1.0 percent by weight.

12. The bullet of claim 10 wherein the powder comprises from 0.05 to 0.50 percent by weight of MoS_2.

13. (Twice Amended) The bullet of claim [1] 53 wherein the [powder further] frangibility effecting additive comprises a nitride additive.

14. The bullet of claim 13 wherein the nitride additive is selected from the group consisting of HBN, SiN, AlN and combinations thereof and the amount of nitride additive is from 0.05 to 1.0 percent by weight.

15. (Twice Amended) The bullet of claim [1] 53 wherein the [powder further] frangibility

effecting additive comprises an oxide additive and a solid lubricant additive.

16. The bullet of claim 15 wherein the oxide additive is selected from the group consisting of SiO_2, Al_2O_3, TiO_2,, and MgO and the solid lubricant additive is selected from the group consisting of graphite, MnS, and CaF_2 and the combined amount of oxide and solid lubricant additives is from 0.05 to 1.0 percent by weight.

17. (Twice Amended) The bullet of claim [1] 53 wherein the [powder further] frangibility effecting additive comprises a carbide additive.

18. The bullet of claim 17 wherein the carbide additive is selected from the group consisting of WC, SiC, TiC, NbC and combinations thereof and the amount of carbide additive is from 0.05 to 1.0 percent by weight.

19. (Twice Amended) The bullet of claim [1] 53 wherein the [powder further] frangibility effecting additive comprises a boride additive.

20. The bullet of claim 19 wherein the boride additive is selected from the group consisting of TiB_2, ZrB_2, CaB_6 and combinations thereof and the amount of boride additive is from 0.05 to 1.0 percent by weight.

21. (Amended) The bullet of claim [1] 53 wherein the powder is a prealloyed brass containing from 5 to 40 percent by weight of zinc.

22. (Amended) The bullet of claim [1] 53 wherein the powder is a mixture of copper powder and from 5 to 40 percent by weight of zinc powder.

23. (Amended) The bullet of claim [1] 53 wherein the powder is a prealloyed bronze containing from 2 to 20 percent by weight of tin.

24. (Amended) The bullet of claim [1] 53 wherein the powder is a mixture of copper powder and from 2 to 20 percent by weight of tin powder.

25. Ammunition comprising the bullet of claim 1.

26. (Thrice Amended) A method of making a frangible bullet which comprises pressing a powder containing at least 60 percent by weight copper in a die to form a pressed powder compact and subsequently sintering [it under conditions] said pressed powder compact, wherein said sintering is partially impeded either

(i) by the addition of a frangibility effecting additive to said powder, or

(ii) through control of density of said pressed powder compact, or

(iii) through control of sintering temperature, or sintering time, or

any combination of the above; so as to produce a bullet capable of fragmenting upon impact with a target.

27. The method of claim 26 wherein the pressing of the powder is performed at a pressure ranging from 50 to 120 ksi.

28. The method of claim 27 wherein the pressing is done at a pressure ranging from 60 to 100 ksi.

29. The method of claim 26 wherein the sintering is performed in a protective atmosphere at a temperature ranging from about 1500 to about 1900 °F for a length of time ranging from about 10 to about 120 minutes.

30. The method of claim 29 wherein the sintering is done at a temperature of 1600 to 1800 °F when the powder is copper, between 1600 and 1700 °F when the powder is brass and between 1500 and 1600 °F when the powder is bronze.

31. The method of claim 29 wherein the protective atmosphere is nitrogen or a mixture of nitrogen and hydrogen or reaction products of a combusted hydrocarbon.

32. The method of claim 29 wherein the sintering time is between 15 and 45 minutes.

33. The method of claim 26 wherein the bullet is repressed after the sintering step.

34. The method of claim 33 wherein the bullet is resintered after repressing.

35. (Thrice Amended) A powder useful for manufacturing a frangible item by pressing in a die and subsequently sintering, said powder comprising at least about 60 percent by weight copper and [an] <u>a frangibility effecting</u> additive selected from the group consisting of an oxide, a solid lubricant, a nitride, a carbide, a boride, and combinations thereof.

36. A powder of claim 35, wherein the amount of the additive is from 0.05 to 1.0 percent by weight of the powder.

37. A powder of claim 35, wherein the additive is an oxide selected from the group consisting of SiO_2, Al_2O_3, TiO_2., MgO, MoO_3, and combinations thereof.

38. A powder of claim 37, wherein the amount of the oxide additive is from 0.05 to 1.0 percent by weight of the powder.

39. A powder of claim 35, wherein the additive is a solid lubricant selected from the group consisting of graphite, MoS_2, MnS, CaF_2, and combinations thereof.

40. A powder of claim 39, wherein the amount of the solid lubricant additive is from 0.05 to 1.0 percent by weight of the powder.

41. A powder of claim 35, wherein the additive is a nitride selected from the group consisting of HBN, SiN, AlN, and combinations thereof.

42. A powder of claim 41, wherein the amount of the nitride additive is from 0.05 to 1.0 percent by weight of the powder.

43. A powder of claim 35, wherein the additive is a carbide selected from the group consisting of WC, SiC, TiC, NbC, and combinations thereof.

44. A powder of claim 43, wherein the amount of the carbide additive is from 0.05 to 1.0 percent by weight of the powder.

45. A powder of claim 35, wherein the additive is a boride selected from the group consisting of TiB_2, ZrB_2, CaB_6, and combinations thereof.

46. A powder of claim 45, wherein the amount of the boride additive is from 0.05 to 1.0 percent by weight of the powder.

47. A powder of claim 35, wherein the additive is a combination of an oxide and a solid lubricant.

48. A powder of claim 47, wherein the oxide additive is selected from the group consisting of SiO_2, Al_2O_3, TiO_2. and MgO and the solid additive is selected from the group consisting of graphite, MnS, and CaF_2 and the combined amount of the oxide and solid lubricant additives is from 0.05 to 1.0 percent by weight.

49. (Amended) A powder of claim 35, wherein the powder further contains from 5 to 40 percent by weight of zinc powder.

50. (Amended) A powder of claim 35, wherein the powder further contains from 2 to 20 percent by weight of tin powder.

51. (Amended) A powder of claim 35, wherein the powder comprises a copper alloy comprised of from 5 to 40 percent by weight of zinc.

52. (Amended) A powder of claim 35, wherein the powder comprises a copper alloy powder

comprised of from 2 to 20 percent by weight of tin.

53. (New) The bullet of claim 1, wherein the sintering is partially impeded by addition of a frangibility effecting additive to said powder; said additive being selected from the group consisting of an oxide, a solid lubricant, a nitride, a carbide, a boride, and a combination of any thereof.

54. (New) The method of claim 26, wherein the sintering is partially impeded either

(ii) through control of density of said pressed powder compact, or

(iii) through control of sintering temperature, or sintering time, or any combination thereof.

55. (New) The bullet of claim 1 wherein the sintering is partially impeded either

(ii) through control of density of said pressed powder compact, or

(iii) through control of sintering temperature, or sintering time, or any combination thereof.

56. (New) The bullet of claim 55, wherein the powder is a dispersion strengthened copper powder.

57. (New) The bullet of claim 56 wherein the dispersion strengthened copper powder is made by internal oxidation of a dilute solid solution alloy of copper and a reactive element selected from the group consisting of Si, Al, Ti, and Mg.

58. (New) The bullet of claim 55, wherein the powder is a prealloyed brass containing from 5 to 40 percent by weight of zinc.

59. (New) The bullet of claim 55, wherein the powder is a mixture of copper powder and from 5 to 40 percent by weight of zinc powder.

60. (New) The bullet of claim 55 wherein the powder is a prealloyed bronze containing from 2 to 20 percent by weight of tin.

61. (New) The bullet of claim 55 wherein the powder is a mixture of copper powder and from 2 to 20 percent by weight of tin powder.

62. (New) The bullet of claim 55, wherein the powder comprises at least about 99.5 percent by weight copper.

63. (New) The bullet of claim 55, wherein the powder is a mixture of about 90 percent by

weight copper and about 10 percent by weight tin.

64. (New) The bullet of claim 55, wherein the powder is a mixture of about 70 percent by weight copper and about 30 percent by weight zinc.

65. (New) The bullet of claim 55, wherein the powder is a prealloyed bronze containing 10 percent by weight tin.

66. (New) The bullet of claim 55, wherein the powder is a prealloyed brass containing 30 percent by weight zinc.

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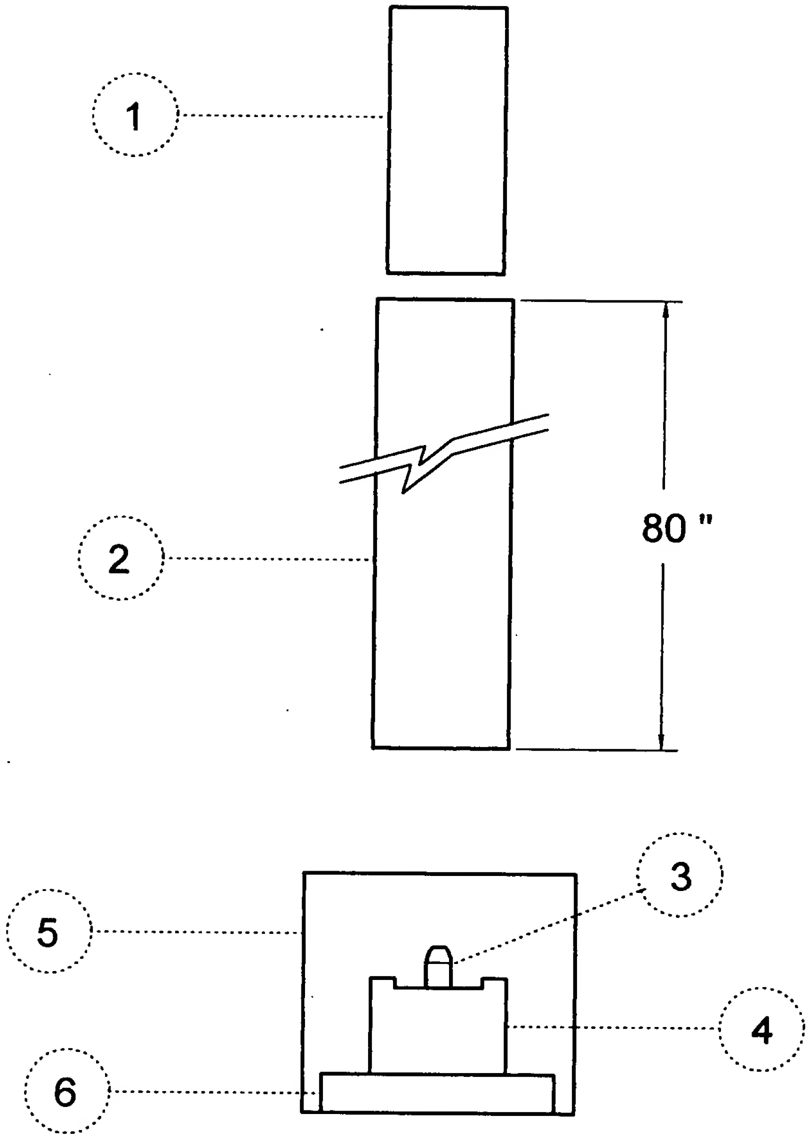

ITEM 1: 14 POUND DROP WEIGHT

ITEM 2: GUIDE TUBE

ITEM 3: BULLET

ITEM 4: ANVIL

ITEM 5: PLASTIC SHIELD

ITEM 6: BOLSTER PLATE

NOTE: A PLASTIC SHEET IS PLACED UNDER THE BOLSTER PLATE TO COLLECT BULLET FRAGMENTS

DROP TEST SCHEMATIC

FIGURE 1